Benefits of Western GREENBRIER Co-production Demonstration Project

Clean Coal Power Initiative

Demonstration of an 85 Megawatt ALSTOM Compact Inverted Cyclone CFB in a Co-production Facility

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Executive Summary

- Demonstration projects are critical to successful commercialization of technology developed under DOE's Fossil Energy R&D program.
- Facility will employ circulating, fluidized-bed (CFB) furnace technology burning waste coal, along with environmental safeguards that places it among cleanest and most cost-effective coal burning electric generation facilities.

Executive Summary (Continued)

- Success of Western Greenbrier Co-Production Demonstration project will set an example for remediation and recovery of large number of legacy waste coal dumps produced from historic coal mining and preparation operations.
- Project carries with it potential for substantial environmental and economic benefits throughout coal mining areas.
- West Virginia Department of Environmental Protection estimates 300 to 400 million tons of waste coal in dumps across southern part of state as state's number one environmental hazard.

Executive Summary (Continued)

- Dumps impose ongoing costs in containment, neutralization of acid runoff and assurance of integrity of containment structures. Estimates to eliminate them run as high as 2 to 3 billion dollars.

- Along with its 85 megawatts of electric power, plant will produce ash which, after treatment, is suitable to produce building materials and for use in acid mine waste neutralization.

Executive Summary (Continued)

- An "Eco-Park" is visualized which complements co-production facility, using steam and hot water. Planned Eco-Park products could include vegetables and talapia, a fast-growing food fish suitable to "fish farm" operation.

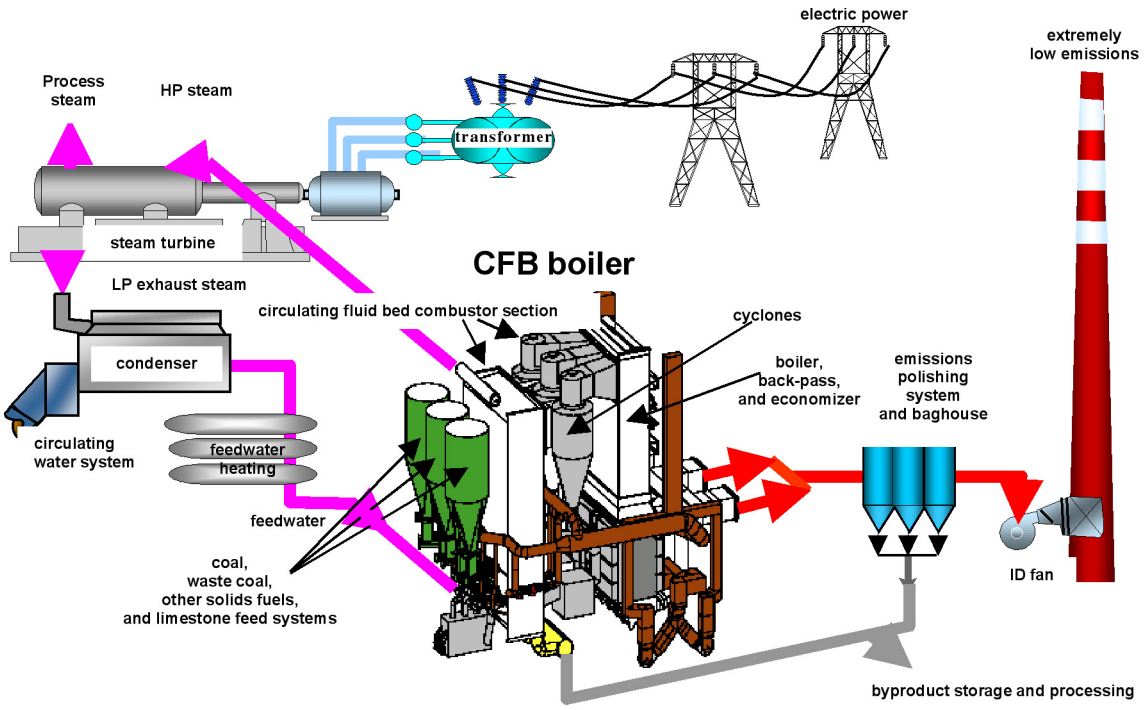
- Co-production project will, in addition to its technology and environmental benefits, provide an income stream to three small communities that will own it, as well as lasting, quality jobs.

Outline

- Western Greenbrier Project Basics
- Team Composition
- CFB System
- ALSTOM CFB
- Air Emissions Comparison
- Woodbrik™ Manufacturing
- Fuel/Coal Supply
- Regional Benefits
- National Benefits

Western Greenbrier Project Basics

- A new 85 MWe ALSTOM Circulating Fluidized-Bed Combustor (CFB), firing waste coal recovered from abandoned coal dumps and adjusted to an acceptable Btu value by addition of higher-quality coal, either newly mined or recovered from fines ponds.
- Treatment of CFB fly ash to increase its calcium content to resemble that of "C" ash, which is more pozzolanic than usual "F" ash realized from burning Eastern United States Bituminous Coal.



Western Greenbrier Project Basics (Continued)

- Co-production of Woodbrik™, a structural building material made by blending treated CFB ash with green wood waste from nearby forest products industries.
- Return of treated CFB ash to waste coal dump to neutralize acid runoff from area.
- Sale of treated ash to other ready markets such as a cement additive for use in construction.

Project Team

- WGC Co-generation, LLC is structured as a municipal entity, owned by neighboring WV towns of Rainelle, Quinwood and Rupert. Project will be sited in Rainelle.
- Parsons E & C (Reading, PA) will provide system design and manage construction.
- ALSTOM Power (Windsor, CT) will provide power island.
- Hazen Research (Golden, CO) will develop ash by-product processes and facilities design.

CFB System

- CFB system differs from other furnaces in that fuel particles are co-fed into furnace, along with limestone particles, and recirculated through a loop formed by furnace box, a cyclone where solids and flue gas are separated, and a solids chute from cyclone that reintroduces solids, consisting of coal, ash, and limestone, into bottom of furnace.
- With continuous fresh coal and limestone feed, material is drawn off at bottom of furnace to control amount of solids in circulating “loop.”

CFB System (Continued)

- **Driving force to fluidize reaction mass is combustion air which enters furnace at bottom and sweeps material upward.**
- **Presence of fresh limestone, coal and ash in reaction mass creates a combustion zone that is much lower in temperature than in a pulverized-coal fired furnace.**
  - 1,600°F combustion temperature is lower than conditions favorable to formation of NOx, so CFB produces less NOx than competing technologies.

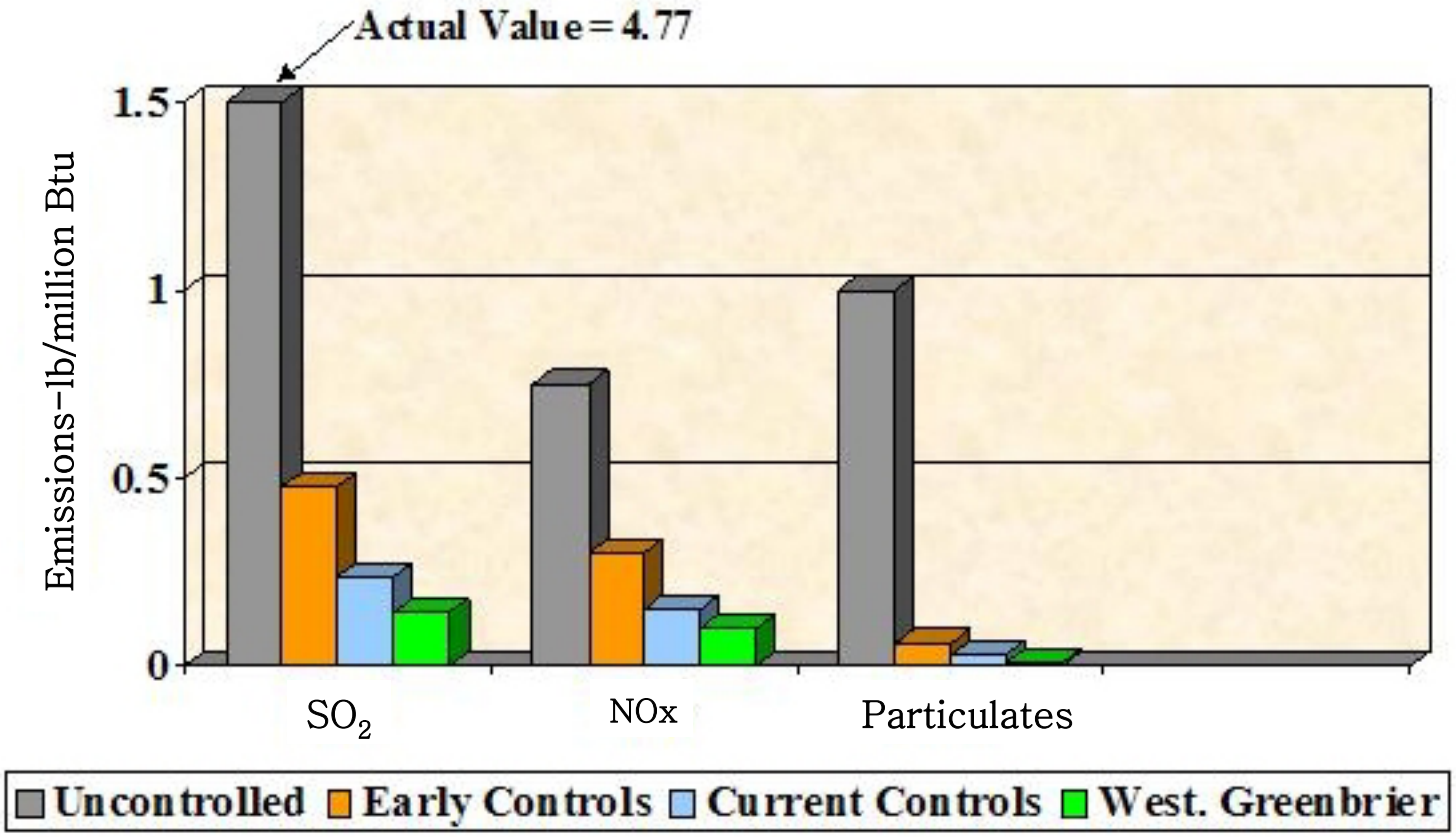
CFB System (Continued)

- Lower heat flux which is direct result of a lower-temperature reaction mass is compensated for by water-wall construction of furnace which provides necessary large heat exchange surface.
- Primary purpose of limestone is to absorb sulfur from coal as it is released by combustion, thereby reducing oxides of sulfur in flue gas. NOx and SOx that remain in flue gas after cyclone are further reduced by selective noncatalytic reduction (SNCR) and wet lime scrubbing, respectively.

ALSTOM I²CMS CFB

- **CFB boiler features a unique "inverted" cyclone separator and a mid-support structure. Together, these provide following benefits:**
  - A 40% smaller boiler footprint with a lower overall building height, decreasing overall structural steel tonnage by 60%.
  - Less direct construction labor.
  - Self-supporting assembly process for enhanced construction safety and reduced costs.
  - Overall construction time cut by 6-8 weeks.

Western Greenbrier Emissions Comparison



Woodbrik™ Manufacturing

- Twelve percent of CFB ash to be used on-site in manufacture of Woodbrik™.
- Woodbrik™ is a unique building material fabricated from “waste” materials, treated fly ash from CFB and wood waste from local forestry industry.
- Standard product will be a certified 35 pound building block measuring 24 by 12 by 4 inches with holes and notches for rebar and grout.

Woodbrik™ Manufacturing (Continued)

- **Woodbrik™ is typically made with Class C ash which has adequate calcium content to be quite pozzolanic.**
  - Local coals typically form a Class “F” fly ash which has a low calcium content and must be bolstered by addition of calcium via limestone. Limestone from Lewisburg, WV area is available for this purpose as well as for sulfur capture in CFB.
- **Woodchips, treated ash and water are mixed, put into molds and allowed to cure.**

Woodbrik™ Manufacturing (Continued)

- Plant capacity is 15,000 standard (24 x 12 x 4 inch) bricks per day.
- Woodbrik™ forms a complete, self-supporting exterior wall system for buildings up to 2 stories high, is fire resistant, has insulating properties, and nails can be driven into it.

- Woodbrik™ "bricks" can be cast in a variety of sizes and configurations.

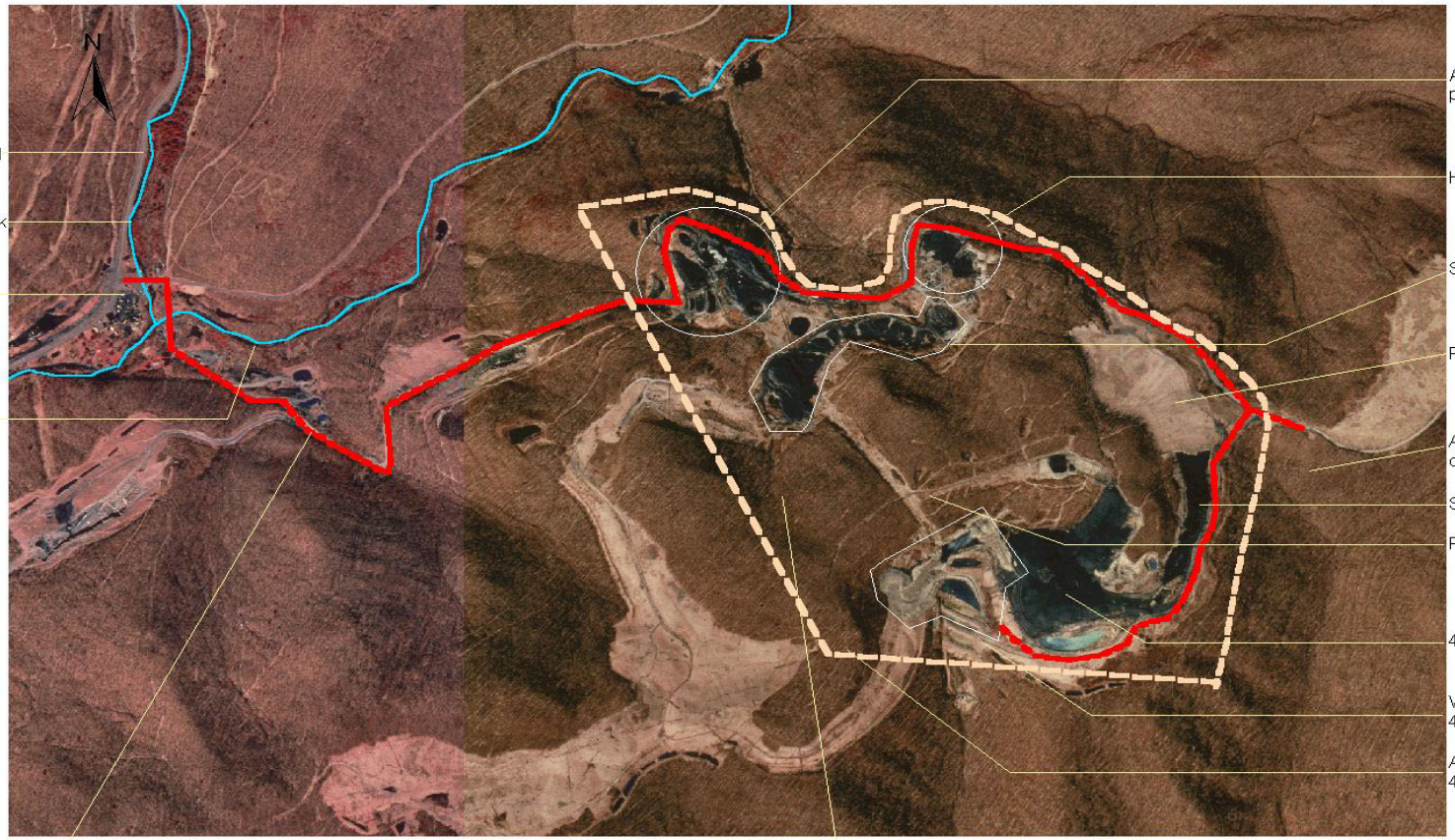
Fuel/Coal Supply

- Primary fuel for CFB will be waste coal from local abandoned refuse coal piles.
- Some higher quality (higher Btu) coal, either newly mined or from fines ponds, will be blended with waste coal to meet CFB's minimum fuel Btu requirement.
- Identified local, available supplies of waste coal far exceed amount required for plant to operate for 20 years, which is normal life of such a plant.

Anjean Site Aerial Photo

Anjean Dump Site Key

Existing Site Conditions



Note: Elevation varies on the site from 3300+/- to 3800 +/-
The property is split between the watersheds of Big Clear Creek and Little Clear Creek.

Prepared For: Western Greenbrier Co-Generation, LLC
Prepared By: Potesta & Associates, Inc.
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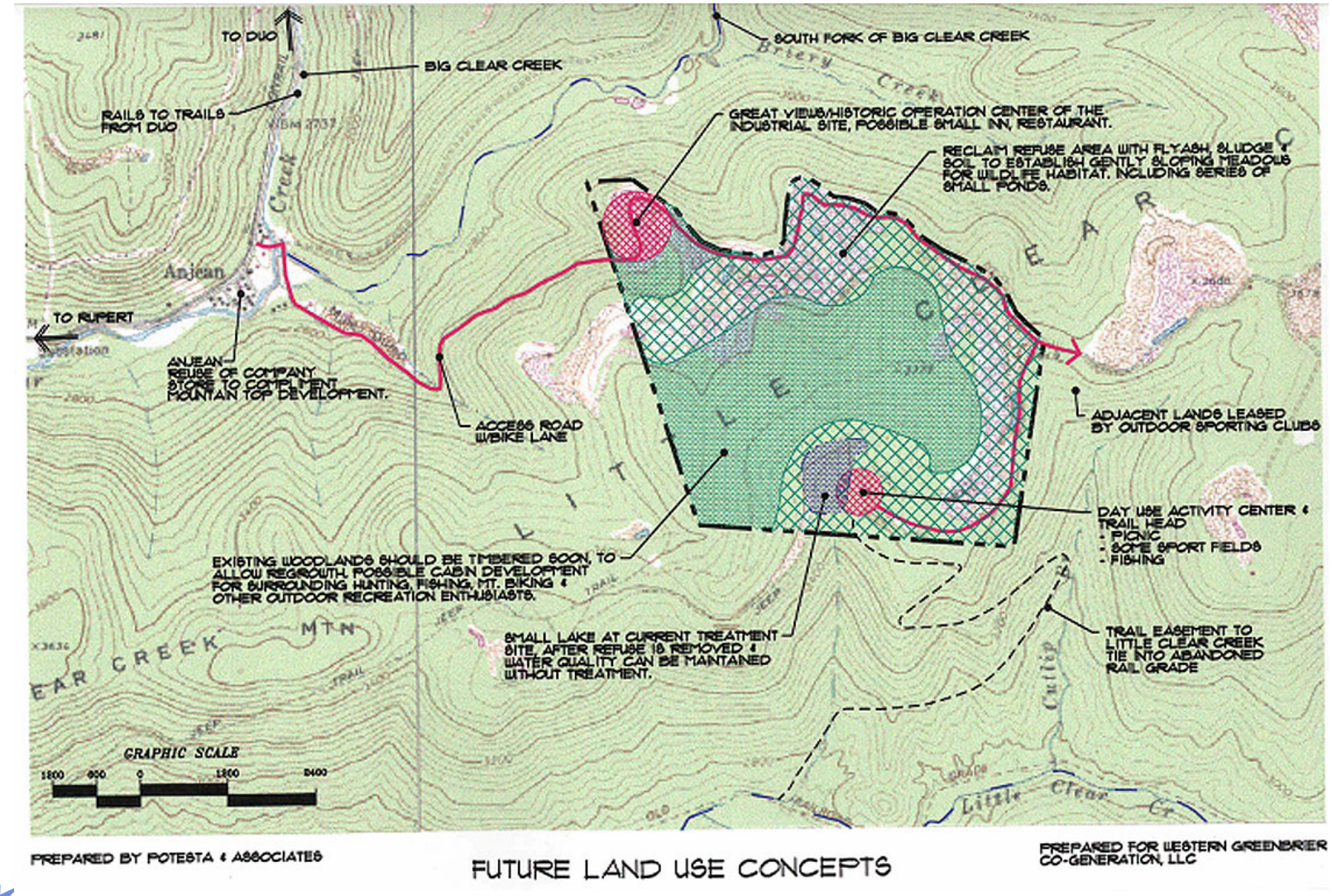
Anjean Annotated Topographic Map



Anjean

- Anjean is name of a tiny town not far from Rainelle which was for many years, location of an excellent coal mine. Remains of that operation are contained in Anjean waste coal dump, consisting of some 4 million tons of waste coal and coal fines.
- Anjean is largest waste coal dump in West Virginia.
- West Virginia DEP spends $250,000 each year monitoring and treating runoff from Anjean dump.
- Residents of area want to reclaim Anjean waste coal dump for use as a community park and recreation area.

Regional Benefits

- **Southern West Virginia faces regional economic challenges. Project will bring high-quality jobs to area.**
  - Construction will bring an influx of skilled labor as well as employment for local labor.
  - Plant operations will create permanent jobs for local residents.
- **Of key importance, Anjean waste coal dump and others like it will be eliminated from landscape, and land will be recovered for beneficial use.**

National Benefits

- Wherever legacy coal mining and preparation operations had occurred, there are likely to be waste coal dumps.
- Project constitutes a model for private industry, local, state, or federal organizations to eliminate these liabilities in a manner that profits, rather than costs, taxpayers.
- West Virginia alone could save 2 - 3 billion dollars.
- Other coal states can benefit from applying this technology to their own waste coal dumps.

National Benefits (Continued)

- **Nationally, large tracts of land, lost for years, would be restored to normal use.**
- **Such facilities can provide incentives to help site future electric power plants, further contributing to our distributed supply system:**
  - from domestic energy sources.
  - more reliable system.
  - provides additional power needed to sustain a growing economy.

Visit NETL web site for information on all Power Plant Improvement Initiative and Clean Coal Power Initiative projects.

www.netl.doe.gov/coalpower/ccpi